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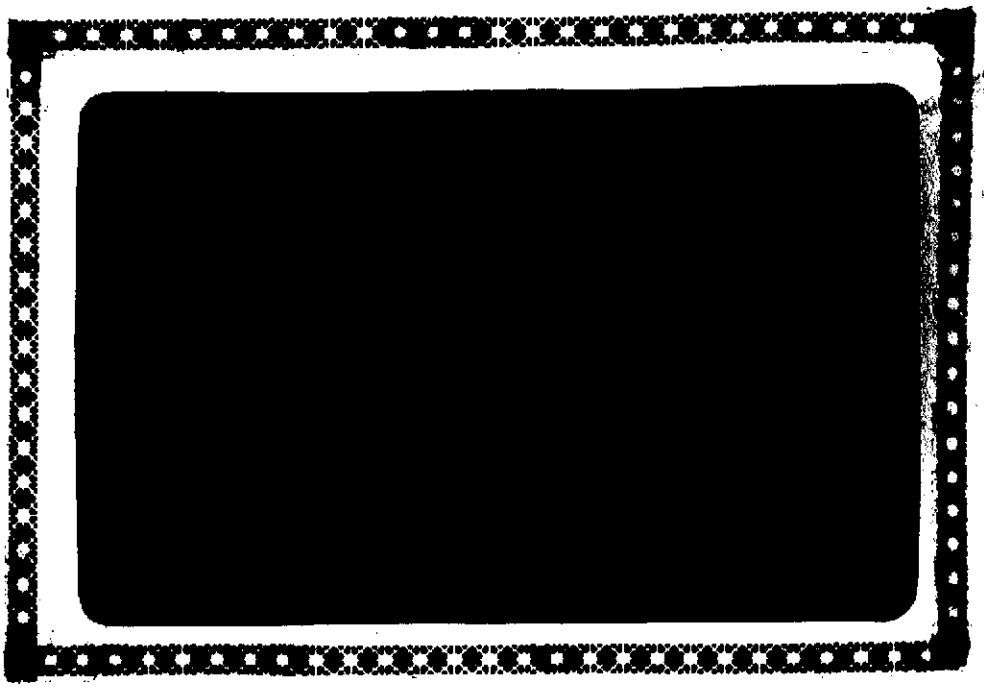

DEPARTMENT OF

PHYSICS

GRAMBLING COLLEGE

Grambling, Louisiana

Semi-Annual Status Report
for a

STUDY OF LOW FREQUENCY HYDROMAGNETIC WAVES USING ATS-1 DATA (NGR-19-011-007)

by

W. D. Cummings
Department of Physics
Grambling College

June 21, 1973

SEMI-ANNUAL STATUS REPORT

SUBMITTED TO:	NASA Scientific & Technical Information Facility P. O. Box 33 College Park, Maryland 20740
REFERENCE NUMBER:	NGR 19-011-007 Supplement No. 2
INSTITUTION:	Grambling College Grambling, Louisiana 71245
TITLE:	A Proposal to Continue Studying Low Frequency Hydromagnetic Waves Using ATS-1 Data
PRINCIPAL INVESTIGATOR:	W. D. Cummings Associate Professor Department of Physics
DURATION:	
(Original Grant)	One (1) Year
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SIGNATURE:
PRINCIPAL INVESTIGATOR

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Introduction:

We are making progress in three areas of our analysis of ATS-1 data.

(1) Cataloging the Pc4 and Pc5 micropulsations observed at ATS-1.

(2) Comparing our data with data from other satellites.

(3) Studying the polarization of the waves.

Cataloging:

The students that have been involved in this phase of the data analysis are Gloria Pleasant, Donald Lyons, and Freddie Mason. Mr. Mason graduated this spring, and Miss Pleasant is not attending the Summer Session this year. I will be working with Donald Lyons in an effort to complete at least six (6) months of the catalog for 1968 before the end of the grant period.

We have completed March, April, and February, 1968 and we are now working on January. This work has gone considerably slower than I had anticipated. As I have mentioned before, it is a very time consuming and tedious job.

However, I have been pleased with the response to the catalog from colleagues both in this country and abroad. We used the UCLA (Magnetospheric

Physics) mailing list to send out copies of the catalogs that we have completed. I am attaching copies of the April and February catalogs, along with a few letters we have received from colleagues.

NASA (JSC) has completed all the microfilm work for the ATS-1 project. We now have microfilm copies of ATS-1 data from December, 1966 through December, 1969. UCLA has also sent us copies of the corresponding 15 second average data on microfilm.

It is becoming clear from the cataloging we have already done that the dominant micropulsation period at ATS-1 is around 60 seconds. This is much lower than the dominant period observed on the ground (See for example, Fig. 10 of (Samson and Rostocker, 1972). Perhaps, as we suggested in 1968 (Cummings et al., 1968), we are observing the second harmonic of a standing wave resonance at ATS-1, whereas ground observers are reporting the fundamentals.

Comparison With Data From Other Satellites:

We have begun to use our catalog in a way that I hope will become common for others working in magnetospheric physics. In preparing a talk on our work, I came across the articles by Chappell (Chappell et al., 1971; Chappell, 1972) in which he reports an OGO-5 observation of an apparent "peeling off" of the bulge of the plasmasphere. One of his observations was on March 30, 1968 (Figure 12 of Chappell, 1972), which is the same day we observed oscillations of unusually low frequency (our event #47 in the March, 1968 catalog). We are preparing a paper that will suggest that ATS-1 encountered the detached portion of the plasmasphere as it was being convected sunward. We will attribute the low frequency oscillations observed during the encounter to the relatively high plasma density in the detached "cloud."

Calvin Countee is the student working on this part of the project. We have completed the power spectrum for the interval for 2336 U.T. of March 30 to 0036 U.T. of March 31 and we are preparing the data to run a power spectrum for an hour previous to the above interval. We would like to know, as closely as possible, when the oscillations were first observed at ATS-1. Hopefully, we can estimate the drift velocity of the cloud by using both OGO-5 and ATS-1 data.

We have also attempted a comparison of our data with data from the DODGE satellite. One of the most interesting cases occurred on March 25, 1968. During the interval 2150-2250 U.T. ATS-1 and DODGE were within one half an earth radius of each other. In the interval 2152-2208 U.T. oscillations were observed at DODGE, but no oscillations could be detected at ATS-1. From 2235-2243 U.T. a brief burst of oscillations was observed at ATS-1. No data from DODGE is available in this same interval, so we cannot know if oscillations were also occurring at DODGE at this time. However, the period of the oscillations observed at DODGE in the interval 2152-2208 U.T. was 41.8 $\pm$ 0.6 sec., while the period of the oscillations observed at ATS-1 in the interval 2235-2243 U.T. was 56.5 $\pm$ 4.6 sec.

I think this kind of observation will be important as a test of the various theories of magnetospheric resonance that are currently in the literature (e.g., Obayashi and Jacobs, 1958; Cummings et al., 1969; McClay, 1970; and Southwood, 1973). Obviously more observations are needed.

Freddie Mason and Calvin Countee have been the student workers mainly responsible for this part of the data analysis.

Polarization:

We have done some preliminary work in this area, but I'm not very satisfied with the results yet. The preliminary work has involved getting

a plot routine to work on the computer at Louisiana Tech. Our computer is not large enough to handle the plot routine.

The routine is working, and the computer now plots the polarization ellipses for us, using letters of the alphabet as plotting symbols. In this way, we can easily tell the shape and sense of the polarization ellipse.

We have been concentrating on a few very long events, such as the one on January 18, 1967. We wanted to see if there is a definite relationship between the sense of polarization and local time, as has been suggested for the ground observed micropulsations (Samson and Rostoker, 1972). We simply haven't done enough cases to tell yet.

Calvin Countee has worked on this part of the project. A new student worker, Akundi Murty, is now primarily responsible for the work.

REFERENCES

Chappell, C.R., K.K. Harris, and G.W. Sharp, The Dayside of the Plasmasphere, J. Geophys. Res., 76, 7632, 1971.

Chappell, C.R., Recent Satellite Measurements of the Morphology and Dynamics of the Plasmasphere, Reviews of Geophys. and Space Physics, 10, 1972.

Cummings, W.D., R.J. O'Sullivan, and P.J. Coleman, Jr., Standing Alfven Waves in the Magnetosphere, J. Geophys. Res., 74, 778, 1969.

McClay, J.F., On the Resonant Modes of a Cavity and the Dynamical Properties of Micropulsations, Planetary Space Science, 19, 897, 1970.

Obayashi, T. and J.A. Jacobs, Geomagnetic Pulsations and the Earth's Outer Atmosphere, Geophysical Journal, 1, 53, 1958.

Samson, J.C., and G. Rostoker, Latitude-Dependent Characteristics of High-Latitude Pc4 and Pc5 Micropulsations, J. Geophys. Res., 77, 6133, 1972.

Southwood, D.J., The Behaviour of ULF Waves and Particles in the Magnetosphere, Planetary Space Science, 21, 53, 1973.

Catalog of Low-Frequency Oscillations of the Earth's Magnetic Field as Observed at ATS-1 During April, 1968

by

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Publication No. 39-73-1

Division of Liberal Arts
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Catalog of Low-Frequency Oscillations of the Earth's Magnetic Field as Observed at ATS-1 During April, 1968

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Introduction

The attached catalog of events has been prepared to facilitate a comparison of ATS-1 data with other ground and satellite magnetometer data. We have begun the catalog in March, 1968, when the ATS-1 data begins to overlap data from the DODGE satellite. We intend to continue the catalog through 1968, and eventually come back to January and February. We also hope to catalog our data for 1967 and 1969.

Explanation of the Catalog

In this catalog an event is defined as an oscillation of the magnetic field with a duration of at least ten minutes, and a frequency that remains roughly constant. Events are distinguished on the basis of the frequency of the oscillation, e.g., when a high frequency oscillation is superimposed upon a lower frequency oscillation, two events are identified.

The oscillations of an event usually occur in bursts that are typically one hour in duration. In a burst the amplitude of the oscillation begins at a low level, grows to a maximum, and then decreases to a low level again. Because the oscillation begins with a low amplitude, it is often difficult to exactly specify the beginning time of the event.

The beginning time is given in Universal Time. ATS-1 is stationed in the geographic equatorial plane at a geocentric distance of 6.6 R_E and at 150° W longitude. One can easily arrive at the Local Time for the beginning of the event by subtracting 10 hours from the Universal Time (or by adding 14 hours if the hour of the beginning time (U.T.) is less than 10).

Gaps of as much as an hour may occur between bursts in a given event. However, we define the duration of an event as the time interval between the beginning of the first burst and the end of the last burst.

We have used microfilm copies of the data at 0.32 second averages to measure the time interval between successive peaks. We tried to make at least ten such measurements during an event to determine the average period. In a few cases we were unable to make ten measurements, but in all cases we made at least five. The error figure associated with the average period is the standard deviation of the individual measurements of the period. This error figure is more a measure of the real variability of the time interval between successive peaks than it is of uncertainty in determining that time interval.

The average frequency was determined by inverting each individual measurement of the time interval between successive peaks and then averaging these individual measurements of the frequency. The error figure associated with the average frequency is the standard deviation of the individual measurements of the frequency.

Acknowledgements

Our work is supported by the National Aeronautics and Space Administration through grant NGR-19-011-007.

Low Frequency Oscillations in the Earth's Magnetic Field

Observed at ATS-1

April, 1968

Event No.	Beginning Time (U.T.) Day	Hour	Min.	Duration (Min.)	Average Period T(Sec.)	Average Frequency f(milli-Hz)
01	Apr. 01	21	48	15	50.7 ± 8.5	20.3 ± 3.6
02	02	00	59	147	105.4 ± 13.1	9.6 ± 1.2
03	03	18	54	78	55.3 ± 5.0	18.2 ± 1.7
04	04	04	15	46	80.3 ± 6.7	12.5 ± 1.1
05	05	00	06	103	129.3 ± 11.7	7.8 ± 0.7
06	06	03	02	100	95.9 ± 28.5	11.3 ± 3.4
07	06	15	12	278	31.9 ± 6.3	32.6 ± 6.7
08	06	22	22	98	78.5 ± 3.6	12.8 ± 0.6
09	09	20	19	401	141.3 ± 17.1	7.2 ± 0.9
10	10	21	17	173	79.5 ± 6.7	12.7 ± 1.1
11	11	01	56	126	105.3 ± 9.9	9.6 ± 1.0
12[a]	11	16	02	13	125.4 ± 8.3	8.0 ± 0.5
13	13	06	55	125	54.5 ± 6.1	18.6 ± 2.2
14	13	21	56	34	45.5 ± 7.2	22.5 ± 3.6
15	13	23	30	128	61.0 ± 13.2	17.2 ± 4.2
16	14	05	56	34	38.7 ± 4.8	26.2 ± 3.7
17	15	01	10	310	59.5 ± 6.7	17.0 ± 1.9
18	15	19	39	102	27.1 ± 3.5	37.5 ± 5.0
19	17	00	22	48	29.4 ± 8.4	36.1 ± 8.7

Event No.	Beginning Time (U.T.) Day	Hour	Min.	Duration (Min.)	Average Period T(Sec.)	Average Frequency f(Milli-Hz)
20	17	02	02	108	81.0 ± 5.4	12.4 ± 0.9
21	17	18	12	98	55.7 ± 3.8	18.0 ± 1.4
22	23	00	46	29	96.5 ± 14.7	10.6 ± 1.5
23	23	04	07	18	149.0 ± 7.8	6.7 ± 0.4
24	24	08	02	57	49.7 ± 5.5	20.3 ± 2.4
25	25	18	10	48	77.2 ± 2.5	13.0 ± 0.4
26[a]	26	03	12	53	212.7 ± 30.4	4.8 ± 0.7
27[a]	26	10	54	18	69.2 ± 4.9	14.5 ± 1.1
28	27	19	34	56	22.7 ± 2.1	44.5 ± 4.4
29	28	00	54	120	47.9 ± 7.6	21.4 ± 3.4
30	29	12	21	11	102.4 ± 4.7	9.8 ± 0.5
31	30	02	08	21	54.7 ± 3.4	18.3 ± 1.2
32	30	20	22	83	54.7 ± 9.3	18.7 ± 2.8

[a] Measurements made on B_z only.

Catalog of Low-Frequency Oscillations of the Earth's Magnetic Field as Observed at ATS-1 During February, 1968

by

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May 18, 1973

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Catalog os Low-Frequency Oscillations of the Earth's Magnetic Field as Observed at ATS-1

During February, 1968

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Acknowledgements

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Low Frequency Oscillations in the Earth's Magnetic Field

Observed at ATS-1

February, 1968

Event No.	Beginning Time (U.T.) Day	Hour	Min.	Duration (Min.)	Average Period T(Sec.)	Average Frequency f(milli-Hz)
01	Feb. 01	19	18	62	68.8 ± 3.1	14.6 ± 0.7
02	04	18	33	343	71.5 ± 10.1	14.3 ± 2.3
03	06	00	04	78	107.3 ± 4.6	9.3 ± 0.4
04	07	17	30	602	98.0 ± 4.2	10.2 ± 0.4
05	10	01	16	24	119.8 ± 25.1	8.6 ± 1.7
06	11	20	19	93	80.4 ± 10.3	12.6 ± 1.6
07	13	05	21	235	55.8 ± 5.2	18.0 ± 1.6
08	13	12	19	791	75.0 ± 11.8	13.8 ± 2.9
09	14	17	32	548	91.8 ± 13.8	11.2 ± 1.9
10	15	06	39	66	89.8 ± 15.5	11.7 ± 3.1
11	15	19	39	312	44.2 ± 8.8	23.4 ± 4.2
12	17	04	26	62	129.4 ± 23.0	7.9 ± 1.3
13	17	07	58	46	44.0 ± 2.8	22.8 ± 1.4
14	17	10	48	272	78.5 ± 14.0	13.1 ± 2.4
15	17	22	06	158	126.8 ± 21.9	8.1 ± 1.6
16	18	06	48	219	81.3 ± 12.9	12.7 ± 2.7
17	19	00	30	53	64.5 ± 4.6	15.6 ± 1.1
18	19	06	20	123	54.4 ± 8.2	18.8 ± 3.1
19	19	20	53	247	52.3 ± 4.6	19.2 ± 1.6

Event No.	Beginning Time(U.T.) Day	Hour	Min.	Duration (Min.)	Average Period T(Sec.)	Average Frequency f(milli-Hz)
20	Feb. 20	10	50	25	95.2 ± 6.4	10.5 ± 0.7
21	20	17	40	150	35.9 ± 5.1	28.3 ± 3.9
22	20	22	25	145	25.0 ± 4.7	41.0 ± 6.1
23	22	01	37	71	59.3 ± 11.2	17.4 ± 3.4
24	23	17	06	211	77.1 ± 9.0	13.2 ± 2.0
25	23	21	30	160	105.4 ± 1.8	9.5 ± 0.2
26	25	19	22	82	147.4 ± 7.2	6.8 ± 0.4
27	26	17	34	780	134.8 ± 14.8	7.5 ± 0.9
28	28	01	45	495	117.8 ± 18.2	8.7 ± 1.3
29	28	10	40	50	110.8 ± 18.5	9.3 ± 1.6
30	28	20	08	25	142.3 ± 5.6	7.0 ± 0.3
31	28	22	44	211	233.4 ± 41.3	4.4 ± 0.8